Title: Social capital's role for value creation in open innovation networks

Abstract:
This study aims to understand how various types of social capital and relational exchanges effect flows of knowledge resources within open innovation networks, particularly within the context of University and Business collaborations. Generally, university-business relationships are depicted as a link to knowledge resources that are governed by market-based mechanisms. This economic assumption overlooks social contingencies that contribute to value creation between affiliated parties. This study addresses this deficiency by employing a social network analysis technique to define correlations between formal and informal social capital structures that contribute to mutual benefit and value creating knowledge generation. This study finds informal connections are vital for new product development, knowledge diversity and network size but is often overlooked, thereby offering an extension to the open innovation literature.

Introduction:
The purpose of OI activities is to promote the ease of access to new and exploitable knowledge from external sources (Brown and Duguid, 1991; Chesbrough, 2003; Powell 1990; von Hippel, 1988; Ketchen, Ireland and Snow, 2005) and to leverage their own internal ideas and paths to the market (Chesbrough, 2003). By transcending the boundaries of the firm, OI may present opportunities to access new knowledge stocks to aid in new product development which might be difficult to match if the organization was operating in isolation (Chesbrough, 2003, 2007; Chesbrough, West and Vanhaverbeake, 2006; Huizingh, 2011; Sisidoya, Johnson, and Gregoire, 2013). As such, the last 15 years has witnessed a strong trend towards R&D outsourcing and strategic alliances as value chains become more disaggregated due to greater product specialization and technological complexity (Hagedoorn and Duysters, 2002; Gassmann, Enkel and Chesbrough, 2010). This topic has cemented itself into management and innovation research as companies (e.g., Microsoft, P&G) are decentralizing research into university-business relationships as a means to increasing knowledge acquisition to drive innovation (Gassman, Enkel, and Chesbrough., 2010) but is still in need of greater topic diversity (Antons, Kleer and Salge, forthcoming).

As an example, the act of pursuing open innovation activities among University-Business partners is not new. Businesses around the globe have connected with universities to resolve knowledge complexities faced by their organizations since the advent of commercialized applications for scientific research (Rothwell, 1994). However, this trend has significantly increased in prevalence since the bottom quarter the 20th century (Slaughter and Leslie, 1997). Shifts in economic conditions and constrained resources has inspired several governments to develop policy initiatives to encourage universities and organizations to collaborate (e.g. Wilson Report, 2012; BIS, 2012). Nonetheless, the university and business relationship is generally depicted as merely a link to knowledge access or financial resources, with little attention given to the dynamic governance issues that surround the alignment of such diverse partners. For instance, Chesbrough (2003) illustrates the potential for university and business collaboration in the context of an 'open innovation business model', but only briefly mentions the need to develop a relationship through a series of contractual agreements. Others have acknowledged the

extent to which challenges may occur, but have merely focused on the necessary usage of specialized intermediaries to establish relationships (Huizingh, 2012; BIS, 2012). Most research on University-Business relationships focus on the complexities that surround policy making for funding mechanisms and ownership issues (Etzkowticz etal., 2000). This portrayal indicates an underlying assumption that this type of relationship link is of a transactional nature guided by formal mechanisms. In such cases, mere economic incentives alone are deemed sufficient governance mechanisms within the relationship type.

Indeed, economic theorists (e.g. Williamson, 1973; Penrose, 1959) have long proposed market mechanisms as the theoretical explanation for successful economic outcomes in relationships of a transactional nature. But this assumption ignores that a network of relationships between and among businesses and universities can only generate *opportunities* to create value, but not the *realisation* of value (Hughes, Ireland and Morgan, 2007; Hughes, Morgan, Ireland and Hughes, 2014). There are significant organizational differences between a university and a business, and this implies that members of such a collaborative partnership could experience challenges with goal misalignment and differing expectations that hold implications for various facets of strategic alignment (e.g., methods of operation within and towards relationships, the development of trust, opportunity identification and exploitation therein). The variance in value realization for each of those parties and how mutual benefit might be achieved indicates a potential for conflict that hitherto lacks clarity. For example, there are important distinctions between the pursuits of academic and commercial research. Academic research has a primary focus towards expanding knowledge-bases through theoretical development, whereas commercial research is aimed towards pursuing answers for specific problems (Lee and Ling, 2007). These paths to knowledge generation for each of these research focuses also indicates the potential for complexities that has the potential to complicate issues of opportunity identification, definition, creation, coordination and management of activities in a way that result in mutual benefits for both partners, alignment of cultures, and effective management practices (Kogut and Zander, 1994). One of the greatest gaps in the OI literature lies within the prevalent assumption that merely establishing a network will generate value and, therefore, the lack of examinations into how relational elements might function to continually achieve value creation for each partner.

There is a need in the literature to transcend the idea that transactional governance mechanisms within open innovation networks are sufficient in explaining the route to value creation. Social capital must play a role in securing innovative outcomes from OI networks and research collaborations. The process of innovation is largely contingent on complex human and social elements that must be aligned and coordinated to access, release and generate knowledge necessary for novel innovation outputs (Rodan and Gullunic, 2004; Nonaka, 1994; Kogut and Zander, 1992) yet the OI literature remains largely divorced from the work on social capital, inter-organizational relationships and network theory. Currently, the literature over relies on economic and market based mechanisms, especially as a form of governance (e.g., contracts), which overlooks the social complexities of how opportunities for value creation between (and among) affiliated parties might be initiated, developed effectively, maintained, and enacted to the

extent that either party would acquire external knowledge or resources (relevant to innovation) in the absence of immediate returns and guarantees of mutual benefit for both parties (Cross, Parker, Prusak, and Borgatti, 2001).

This study seeks to address this gap by examining the social capital structures that contribute to innovation within a highly-publicized, effective and large scale University–Business relationship that has been built through self-organizing processes over a period of five years. This relationship has maintained high levels of mutual benefit and satisfaction for both partners.

Research Methods:

This study seeks to combine the macro and micro level views of a network to fully illustrate the interactions between the formal and informal social capital that exist among actors. As such, a social network analysis methodology was adopted to map the patterns of social interactions occurring between and within the formal and informal social capital structures and their implications (Kadushin, 2012; Cross and Parker, 2004; Hanneman and Riddle, 2005; Burt, 1995; Wasserman and Faust, 1994; Granovetter, 1973). This methodological approach has the ability to objectively display the contingencies of how knowledge and knowledge resources flow among actors in the network by illustrating the various relational channels (Prell, 2011). This approach emphasizes the importance of identifying the features of a social structure that influence collective action and the flow of interactions between actors define the phenomena of interest (Hanneman and Riddle, 2005). Analysis of these features aids researchers to understand how opportunities or constraints may emerge in the social structure (Adler and Kwon, 2002; Burt, 1995; Granovetter, 1973) utilizing concepts such as density, cohesiveness, clusters and/or transivity (Hanneman and Riddle, 2005). This study seeks to identify and map the relational elements that enable (or constrain) the cross-functional resource flows that enable innovation and define the interactions between network structure, content, and behaviour.

SNA is most benefited from robust data collection as the outset of a social network investigation requires rich descriptions of the relational patterns before further analysis can commence (Hanneman and Riddle, 2005). The first round of data collection focused on developing an understanding of the key actors and influencing parties. This exercise was aimed to categorize the network actors, the content of their knowledge acquisition motives and goals, their roles within the network, who they frequently connected with whom, and how they communicated (Carringion and Scott, 2012). In addition, this data collection phase focused on understanding the development of this network and formal governance mechanisms, along with the hypothetical relational ties that influences the network activity and the types of relational linkages that contribute to value creation and innovation, thereby revealing rich contextual factors and subjective inferences regarding the overarching structural and content related characteristics of the network structure (Ng and Feldman, 1999) by utilizing multiple methods of collecting qualitative data.

Social Network Analysis borrows concepts from graph theoretic notation and relational algebra, which is used to visually display network connections and to serve as information maps in identifying the significant features of a social structure (Borgatti et

al., 2013). This approach adopts specialized terminology and concepts from graph theoretic notation and allows the researcher to approach objectivity through focusing on understanding and presenting the social facts (e.g. relational links), and measuring the intensity and influence of the various social constructs (Cross and Parker, 2004; Hanneman and Riddle, 2005). The analysis aims to explicate social relations that may emerge from a qualitative investigation in a way that is consistent with the scientific methods employed within the natural sciences (Kuhn, 1964) as well as acknowledging that the network includes local conditions (Wasserman and Faust, 1994). The primary objective of this stance is to reliably present consistent and approach objectivity information with regards researched to the measurement of properties and descriptions of the relational patterns (Hanneman and Riddle, 2005).

The analysis for this data set then focused on 'quantifying the qualitative' through the creation of a socio-matrix of non-directional dichotomous relations of non-ordered pairs to represent the formal network structure and the level of obligatory task interdependence between actors with diverse knowledge content. The qualitative data collection exercise provided the opportunity for an objective display of the formal organization and task interdependence. Data collection for the informal networks took the form cross-sectional survey and roster, aimed to collect aspects of the collaboration as perceived by actors.

Analysis and Key Findings:

The formal structure of the network is coordinated in a way that encourages opportunity among the members. The formal network structure was defined by the coordination made by contractual arrangements and the obligatory task interdependence as outlined in the Master Agreement. This merely illustrates the network connectivity among actors' specific functions, which has been assumed to be the guiding force in facilitating the generation of the knowledge and innovation outputs. As illustrated, the formal structure is coordinated in a way that encourages opportunity fluidity among the members. However, there is evidence of distinct variance among the actors positions and the density of their connections, which has implications for how each actors obtains or pursues the opportunities (or constraints) available within the relationship (Burt, 1995; Granovetter, 1973).

For instance, the evidence of the actors' formal contracts and their assigned task interdependence only reveals an average of three required connections, but knowledge creation can be dependent on the collaborative processes and social activity developed within the organization. The observations from this analysis reveals that there are potential points within the network that could facilitate deeper collaboration through the usage of integration mechanism. The presence of structural holes and the facilitation of greater centrality amongst the actors has the potential to generate novel and new knowledge connections if the integration mechanisms are effectively executed. However, the appropriate usage of integration mechanisms requires a deeper understanding of how to effectively design and address the underlying and informal behaviours of network actors, as well as the actors' perceptions regarding the network functioning (Ng and Feldman, 2010). Network opportunities across functions and the knowledge focuses amongst the actors. The successful generation of innovative outputs within this particular research site reveals that although the network has been built strategically, operational

effectiveness might rely on other forms of social obligations that exist beyond the contract.

Therefore, an analysis of the underlying informal relational linkages has the potential to explain the nature of collaboration beyond the contractual elements. There is a striking difference between the formal and informal structures that SNA can reveal (Cross et al., 2001). The evidence supports the theory that this relationship is characterised by multi-relational contingencies and is, therefore, benefited by the access that is granted to the informal connections developed between the human actors. The informal relational ties are characterised by a variety friendship, support, and knowledge acquisition behaviors to reveal the varying degrees of strength and the correlations between the social capital type. This study finds that the informal connections nearly doubles the network size, and increases the diversity of knowledge resources and functional support that is vital for new product development but is often overlooked, thereby offering an extension to the open innovation literature. Therefore, this thesis addresses the call made by Kadushin (2011) to illustrate what the informal network looks like and how this informal network facilitates collaborative behaviour, such that it results in value creation, innovation, network growth, and sustained results.

The analysis also revealed that actors within this network are not isolated to solitary pockets, nor is there a solitary network structure. Within the network, knowledge based clusters have naturally formed. There are dynamic interactions between the portion of the network that maintains a procedural/administrative focus and the portion of the network that has the primary focus on knowledge creation activities. However, some actors have assumed a role to maintain interactions across the various subgroups and have a high level of influence on knowledge flows. While effective in the present functioning, there is a danger of over-reliance on key actors; which may cause burn out, stress, or network disintegration should they cease to be involved as well as group-think as the networks become more embedded (Heider, 1958).

Implications and Contributions:

This study aims to make a contribution to the open innovation literature, particularly those that identify Universities as a potential innovation for businesses. Much of the literature in this area would be benefited with additional insight into the social contingencies that have an impact on the operational effectiveness of this type of relationship. This study has implications for managers and policy-makers as it reveals the complex contingencies necessary for consideration when coordinating, developing and maintaining collaboration within this network type.

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